On The Impact of IT on Value Generating Activities in Organisations: an Ontology Based Approach

Ph.D. Thesis Summary

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1. Introduction and Motivation

IT resources support organisations daily activities by enabling or facilitating business processes activities execution. By doing so, IT resources support the value generation process of the entire organisation. The ensemble of IT resources an organisation might use to support its activities forms the IT infrastructure.

Identifying how IT resources actually impact on value generating activities is not easy (Scheepers and Scheepers 2008, Tallon 2007). Due to nowadays complexity of IT infrastructures, IT resources can easily affect more than one business process. On the basis of the degree of complexity of the IT infrastructure and of the organisation activities, identifying which IT resource impacts which activity can be an easy or very difficult task.

The need to identify the impacts of IT resources on value generating activities is suggested as a promising strategy to investigate and exploit value delivered by IT (Nickels 2004, Tillquist and Rodgers 2005). To be able to practically do it, a methodology to identify the relationships among IT resources and value generating activities in an organisation is required. So far, the only (limited) approach proposed in literature that goes towards this direction is due to Scheepers and Scheepers (2008).

By combining together two different streams of research (IT Business Value and Business Modelling) this Ph.D. dissertation proposes an ontology-based approach to help to identify the impacts of IT resources on value generating activities, to support the study and the analysis of value delivered by IT at a process level. The proposed approach makes use of an ontology, the IT-BM ontology, resulting from the integration of the Business Model Ontology (BMO) and the OLPIT ontology. This integration has been proposed since both the BMO and the OLPIT ontology address different (but complementary) parts of the described problem.

2. Research Question

The Ph.D. dissertation targets the problem of defining a tool to identify the relationships among IT resources and value generating activities in an organisation. The research question the Ph.D. dissertation aims at answering is therefore the following:

> *Q: How is it possible to identify, represent, and communicate the impact of IT resources on value generating activities in an organisation?*

Several elements support this research question. First of all, it addresses the problem of value generating activities in an organisation. It is generally acknowledged that, in organisational context, value production happens thanks to a set of activities, intended as repeatable patterns of actions that are necessary to deliver products and services to the final customer. Therefore, to be able to answer the research question,

it is necessary to identify value generating activities in an organisation, no matter which is the nature (production, or service provision) of the business run by it. The following research proposition is thence formulated:

> *Proposition 1: a general method to identify value-generating activities in an organisation will be investigated.*

The second set of elements that supports the specified research question is the possibility to identify, represent, and communicate the impact of IT resources on value generating activities in an organisation. These elements are discussed together since they all refer to the same aspect. Having identified value generating activities, and given a certain set of IT resources, the question is now how to identify the impact of the latter on the former. To do so, investigating the relationships among IT resources and activities is necessary. Activities per se are not sufficient to explain the value generation process. Activities need to use resources (a subset of which are IT resources), to generate value (Daft, 1983; Wernerfelt, 1984; Barney, 1991; Barney, 1991). Therefore, a necessary step to identify, represent, and communicate the impact of IT resources on value generating activities requires the identification of IT resources that are used for activities execution. The following research proposition is then formulated:

> *Proposition 2: the identification of IT resources used to support activities execution will be investigated.*

Finally, once the value generating activities and the resources used are identified, there is the necessity to represent them, in a form that allows the sharing of the understanding gained on the phenomenon to stakeholders. Therefore the following research proposition is formulated:

> *Proposition 3: a form that enables the communication of the relationships of IT resources and business process activities among people interested in the phenomenon will be investigated.*

2.1 Why an ontology based approach

In the past, the usage of ontologies was mainly restricted to philosophy-related research fields. Nowadays ontologies are more and more used as generic instruments to support knowledge representations and exchanges (Guarino 1998). Grünninger (2003) citing Gruber (1993) defines an ontology as an "*explicit specification of a shared conceptualisation*".

Since ontologies can be described using formal languages, they are good candidates to describe generic organisational related concepts (Force 2003). Once an ontological model has been built, automating software tools can perform reasoning on the model, being able to answer queries regarding, not only what is explicitly represented in the model, but also what is implied by it (Fox et al. 1998).

Moreover, ontologies contain semantics that can be human or machine understandable. Therefore, ontologies allow the sharing of a common understanding on a specific problem, among all the people interested in it. Summarizing, the advantages connected with the use of an ontology to describe phenomena are: model simplicity, easiness of model extensions, and sharing of a common understanding on the phenomena itself.

2.2 Why a new ontology

Several ontologies for individual enterprise-related phenomena are already available. Anyhow, only two ontologies – the Edinburgh Enterprise Ontology (EEO, see Uschold et al. 1998) and the TOronto Virtual

Enterprise (TOVE) (Gruninger, 1998) have been explicitly constructed for the purpose of representing phenomena that encompass the whole organisation (Grünninger, 2003).

These two ontologies considerably overlap in their set of concepts, since they both define classes related to organisational aspects, strategy, activities and time. Both ontologies conceptualise processes, resource usage and costs. However, they do not have IT related concepts.

3. Research Design and Methodology

The research described in the Ph.D. dissertation was divided in two phases. The first phase was focused on the identification of a methodology, available in literature, to model the impact of resources on value generating activities, and its consequent test on a real life context. During this step the BMO has been identified as a suitable instrument for these purposes.

The second phase was focused on the feasibility, the development and the test of an ontology to model IT impacts on value generating activities. During this step the OLPIT ontology has been developed and later integrated with the BMO in the IT-BM ontology. The methodological aspects of the two steps are described in the following sub-paragraphs.

3.1 First step: the identification and the use of the BMO

The BMO has been identified by means of a literature review (Braccini et al. 2008), and has been subsequently tested for eight months in a participatory action research study during the exploitation phase of the LD-CAST European project. This phase is described in details in (Braccini et al. 2008).

According to Baskerville (1999) action research is a set of research approaches, with a pragmatic foundation (Baskerville and Myers 2004), which is considered a better strategy to investigate the organizational impact of information systems (Avison et al. 2001). In action research projects, researchers cooperate with domain actors (or experts) to solve practical problems, expanding, at the same time, their knowledge (Baskerville and Myers 2004). Participatory action research expands the action research approach promoting domain actors to the "co-researchers" status, and extending to them the responsibility of theory formulation (Baskerville 1999). This methodological approach has been chosen due to the active role that the research team has played in the project.

3.2 Second step: development of the OLPIT

The OLPIT ontology has been developed and tested for five months in the context of the IT division of an international tool producer company. The company has an internal IT division that manages global IT services to support sales and customer relationships of its market organizations (located in more than 100 countries worldwide). The project aimed at improving IT infrastructure management to plan decisions on IT investments, to internally and externally benchmark IT activities, and to better communicate IT contribution to business.

The ontology has been developed following the method used by Sure et al. (2003), which is depicted in the fig. 1. The methodological approach is the one of the design science research (Hevner et al. 2004), which involves the analysis of the use, and performance of designed IT artefacts. In this case the "IT artefact" is the IT-BM ontology. The ontology has been modelled with the OWL 2.0 language. The ontology has been evaluated, refined, and validated by means of test cases based on real life examples. The integration of the OLPIT ontology with the BMO has been made with the ontology interoperability process described by Jimenéz-Ruiz et al. (2009).

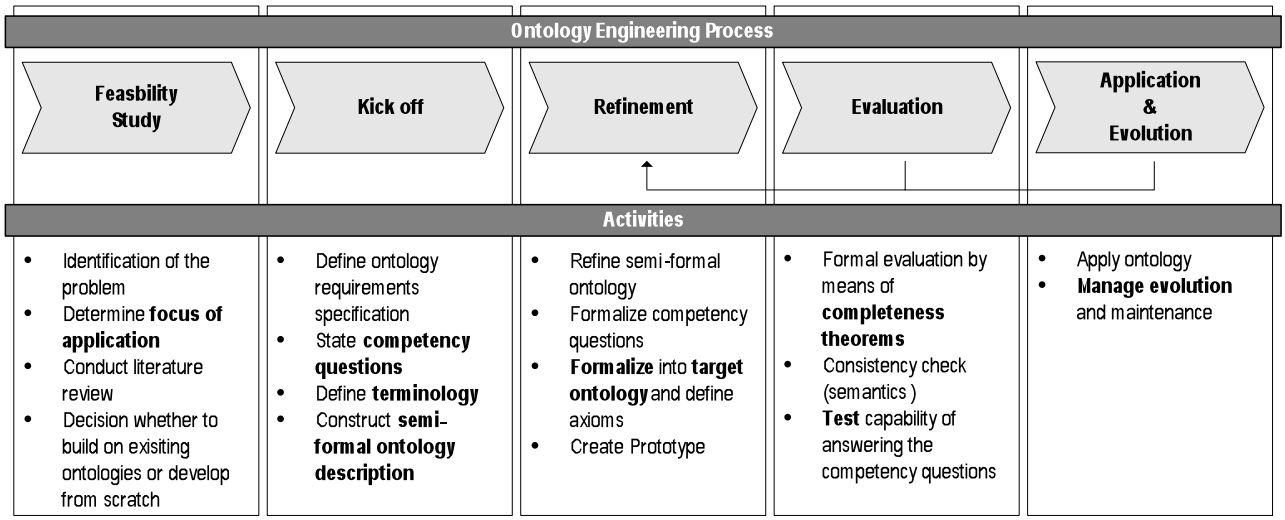

Fig. 1. Ontology Engineering Process

4. Theoretical Framework

The Ph.D. dissertation is centred on the key concept of impacts of IT resources on value generating activities. For the needs of this dissertation, the term "IT resource" is defined as described by Orlikowski and Iacono (2001): a set of technological artefacts (like IT components), and IT personnel (human resources). These IT resources impact value generating activities in a process, altering the ways these activities and business processes are executed. IT impacts are therefore necessary and sufficient conditions for IT business value (Soh and Markus 1995).

IT Business value is the main area, where the problem addressed by the Ph.D. dissertation emerges. IT business value research examines the impact of IT on organizational performance (Melville et al. 2004), to evaluate profitability and effectiveness of IT investments (Seddon et al. 2002). To address this problem, literature has proposed several approaches (Melville et al. 2004), and theoretical perspectives (Oh and Pinsonneault 2007). Results are somehow controversial (Im et al. 2001), because the direction (positive/negative) of the relationship between IT investments and performance is still unclear (Wagner and Weitzel 2007).

Recently, there is a growing acceptance of the importance of analyzing ITBV from a process-based perspective (Tallon 2007), since IT application tends to be process specific (Ray et al. 2007). Melivelle et al. (2004) identified that at process level, IT resources interact with complementary organizational resources contributing to organizational performance, by means of business processes and business processes performance improvements.

The identification of value delivered by IT resources to business processes requires the identification of the IT resources that impacts business processes activities (Wagner and Weitzel 2007, Tillquist and Rodgers 2005). Working towards this perspective, Scheepers and Scheepers (2008) propose to identify value-generating activities relying on Porter's value chain (Porter 2001). This approach is anyhow limited since the value chain framework is a good source to identify value-generating activity of industrial organisations, but it is of no help for identifying activities of service providers.

Service providers deliver value in a different way compared to industrial companies. To overpass the limitations of Porter's value chain framework, Stabell and Fjeldstad (1998) defined, on the basis of Thompson's (1967) typology of technology, value shops and value networks as extensions to the value chain framework.

The advent of ICT on traditional way of doing business offers many opportunities to de-construct traditional value configurations and re-construct them in new configurations that might offer many

opportunities for the creation of new ways of doing business (Schweizer 2005). The theoretical concept of Business Model has been used at the onset of the new economy to synthetically describe new, actual or potential, business ideas or opportunities created by the use of ICT (Lewis 1999, Feng et al. 2001). Basically a Business Model describes the way an organisation "makes money" (Bienstock et al. 2002).

Different organisations (sometimes also competitors) perform therefore business together to deliver value to their customers. This new way of doing business contributed to blur the boundaries of industries, making the business model a good candidate to replace the industry as a unit of analysis to investigate the value generation phenomenon in the new economy era (Osterwalder et al. 2005).

4.1 Identifying value generating activities: the Business Model

The Business Model concept is understood in many different ways, according to the discipline and the point of view adopted to study it (the full text of the dissertation lists, as a matter of example, 25 different definitions of the concept that have been identified in literature. Along with definitions, some authors also propose tools to describe and model real instances of business models.

Among proposed models, the most formal ones are those that make use of an ontology. So far, three different ontologies have been proposed to represent business models: the Resource Event Agent (REA) ontology (McCarthy 1982, Andersson et al. 2006), the e-3 value ontology (Gordijn and Tan 2005), and the BMO (Osterwalder 2004). These ontologies are compared in tab. 1.

	BMO	**e3-value**	**REA**
Origins	Business Model Research	E-Business	Accounting
Theoretical perspective	RBV	Value Network	Value Chains
Supported Value Configurations	Chain/Shop/Network	Network	Chain
Focus	Internal	External	Internal
Plus	Guidance Definition Layered representation	Profit analysis Modelling freedom Supporting tool	Model simplicity Relational Database
Minus	Complexity Partially fixed model Lack of supporting tools	No guidance	Accounting perspective

Tab. 1. A comparison among available ontologies for Business Modelling

Among available ontologies for business modelling, the one that is of best usage for answering the research question of the Ph.D. dissertation is the BMO. The motivation of this choice, which is more deeply discussed in the full text of the dissertation, basically lies on the ontology structure, and in the value configurations adopted.

The BMO (Osterwalder et al. 2005), describes a business model as composed by a set of classes and subclasses, hierarchically organized in pillars, building blocks and components. The structure of the BMO is illustrated in Fig. 2 and 3.

The BMO is then a good candidate to identify value-generating activities of organisations, no matter which is the value configuration they adopt. Anyhow, the BMO alone is no capable of identifying the impacts of IT resources on these activities, mainly because this ontology does not contain specific constructs to model IT resources. For these reasons a new ontology needs to be brought into play: the OLPIT ontology.

Pillars and Building Blocks of the BMO		
Pillar	**Building Block**	**Component**
Product	Value Proposition	Offering
Customer Interface	Target Customer	Criterion
	Distribution Channel	Link Actor
	Relationships	Mechanism
Infrastructure Management	Value Configuration	Activity Actor
	Core Capability	Resource Actor
	Partner Network	Agreement Actor
Financial Aspects	Cost Structure	Account
	Revenue Model	Revenue Stream and Pricing

Fig 2. Class hierarchy of the BMO[1] - based on Osterwalder et al. (2005)

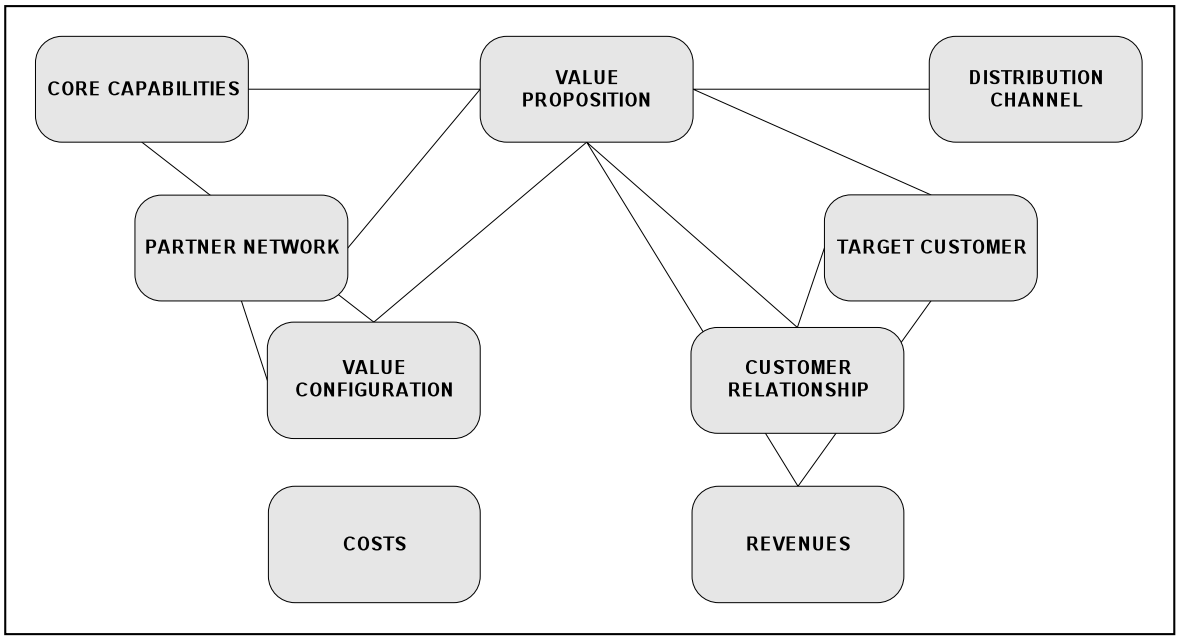

Fig 3. Building blocks (and their relationships) of the BMO – based on Osterwalder et al. (2005)

4.2 Extending the BMO: the OLPIT ontology

Discussing the reasons why an ontology based approach has been adopted in this Ph.D. dissertation, the lack of specific ontologies to address IT resources and their impacts on value generating activities has been identified. Having taken the BMO into considerations to identify value generating activities, a candidate ontology for its extension is the Ontology for Linking Processes and IT (OLPIT) (vom Brocke et al. 2009). In the OLPIT ontology IT resources deliver value to activities of a business process by means of services, as depicted in fig. 4.

[1] For readability reasons, properties and attributes of each class have not been included in the picture.

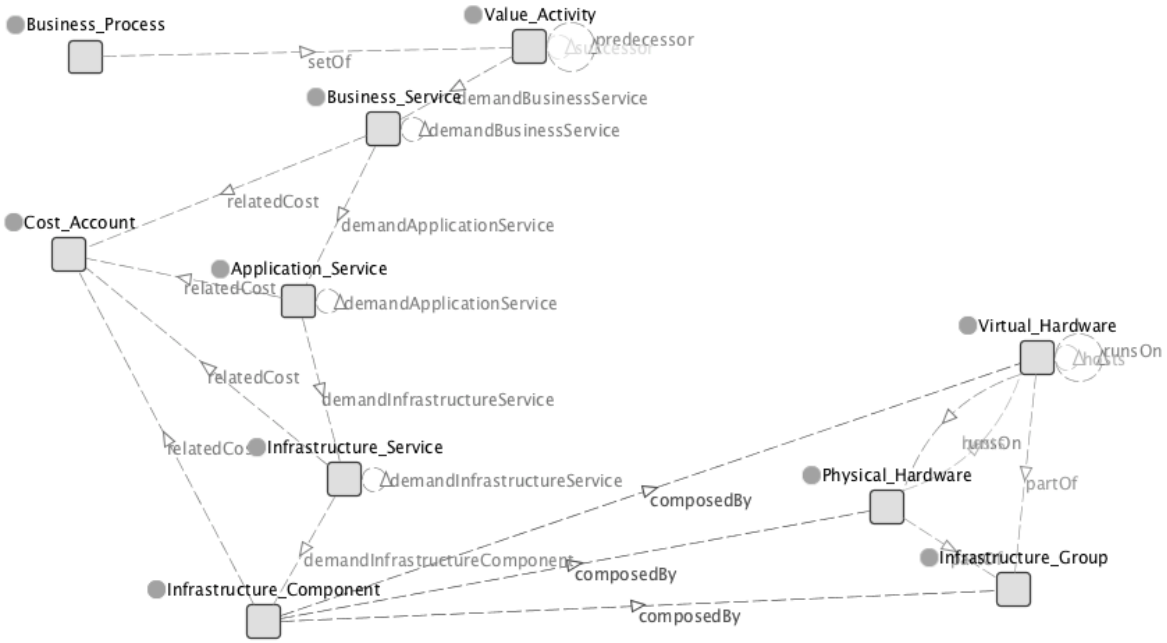

Fig 4. The OLPIT ontology (vom Brocke et al. 2009)

5. The integration of the OLPIT and the BMO ontology: the IT-BM ontology

The integration of the BMO and the OLPIT ontology has been made using the ontology engineering interoperability process described by (Jiménez-Ruiz et al. 2009). The integration has followed the following steps:

- Identification of the classes composing the BMO;
- Identification of the classes composing the OLPIT ontology;
- Comparison of the classes definitions of the BMO and the OLPIT ontology;
- Identification of correspondences among classes;
- Design of the new ontology.

These steps that are described in full details in the Ph.D. dissertation, were necessary to design a new ontology, resulting from the integration of the BMO and the OLPIT ontology. This ontology has been called IT-BM. The full schema of the IT-BM integrated ontology is depicted in Fig. 4.

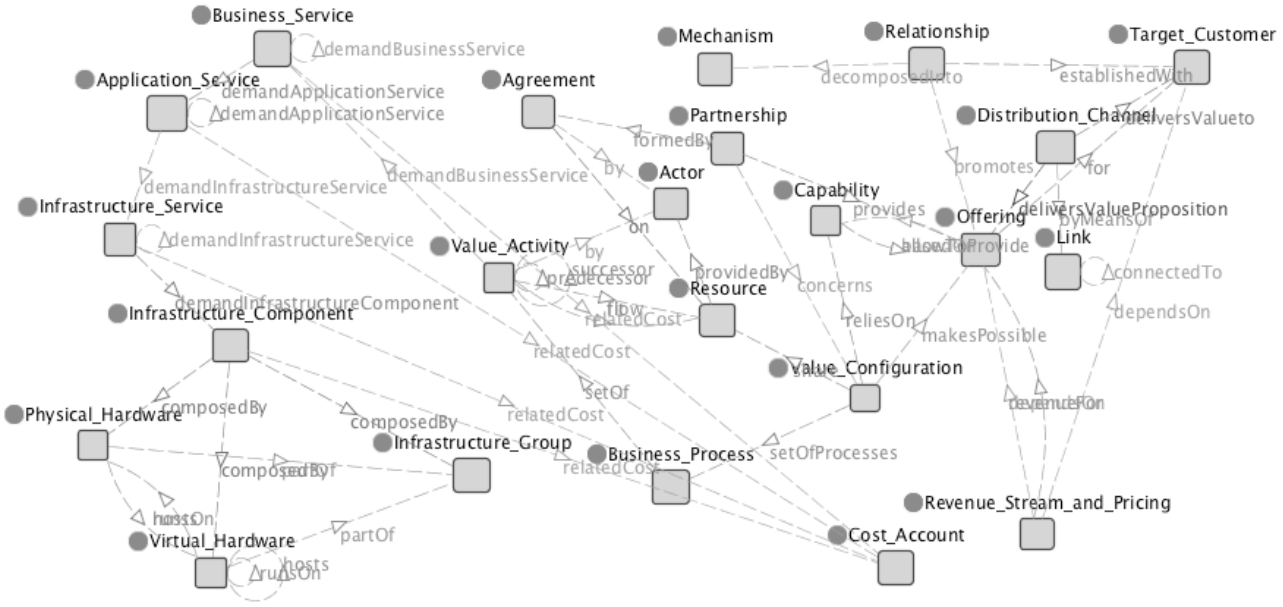

Fig. 5. The IT-BM ontology schema

6. IT-BM Test Case

The IT-BM ontology approach has been tested on a real life scenario. The ontology has been used to identify the impacts of IT resources on value generating activities in ITHUM Srl, an Italian small enterprise working in the ICT market. This test case has been built on the basis of data gathered with interviews with key figures in the organisation. The test case is described in the following paragraphs.

6.1 ITHUM Srl

ITHUM Srl is an Italian SME that offers consultancy and training services in the ICT field. The company is located in Rome, in the centre part of Italy. It is composed by professionals and partners with a long lasting and certified experience in the ICT market.

Selling its services, ITHUM approaches customers with a traditional process to tailor solutions on users' needs. When ITHUM approach customers it starts a cycle of activities that guide it in the understanding of their needs. Usually these activities are: identification of users' needs, formulation of a proposal for the intervention, delivery, training, and after sales support.

ITHUM directly participates in others organisations and institutions like: the consortium “Accademia del Levante”, the spin-off Enetech Srl, and the no-profit organisation called ICT Academy.

6.2 ITHUM’s Business Model

In brief, ITHUM's business model is centred on the provision of training and consultancy services in the Italian ICT market. ITHUM is therefore a service provider that supplies its services in the ICT market. In the following sections ITHUM' business model will be described according to the structure of the IT-BM ontology.

6.2.1 ITHUM’s Value Proposition

ITHUM’s value proposition is basically composed by four different offerings: consultancy on networking, consultancy on new technology, training, and design of training initiatives.

Consultancy services are of two kinds: a first kind of consultancy services offered is the one related to networking. ITHUM offers consultancy services on networking mainly on CISCO Systems hardware. ITHUM takes care of aspects like installation, configuration, and maintenance of CISCO Systems hardware located in customers' offices.

The second kind of consultancy service offered by ITHUM deals with New Technologies in general. This service covers mainly consultancy aspects connected with unbranded ICT solutions, for which ITHUM offers generic consultancy tailored on customers' needs.

The third service offered is a training service. ITHUM, by means of its employers and co-workers, offers training on several topics connected to the ICT domain. ITHUM's training activity is directly supported by ITHUM's consultancy experience that renders ITHUM's training services up to date and in line with the state of the art of the IT market.

Besides to training services, ITHUM also offers the design of training initiatives as a service. With it, ITHUM offers its experience in training in the IT domain to the customers, supporting them in the design and in the creation of training initiatives on the basis of customers' specific training needs.

6.2.2 ITHUM’s Customer Interface

ITHUM sells its services mainly to two groups of customers: small medium enterprises, and individuals. No service appears to be specifically targeted on a specific group of customers. In terms of relevance on ITHUM's turnover, anyhow, the group formed by small medium enterprises tends to be prevalent.

ITHUM's services are delivered to customers by means of two channels: direct contact, and intermediary partners. Direct contact can have many forms. Besides face-to-face contacts, also telephone, e—mail, and web sites are used too.

The relationships with customers are mainly managed by means of service provisioning activities and after sales support. Service provisioning activities are all those that ITHUM requires to practically deliver the services to its customers. They include all activities necessary to identify customers' needs, to identify a solution that suits them, and to deliver such a solution to the customers. After sales support includes instead all the activities executed when the service has already been sold.

6.2.3 ITHUM’s Infrastructure Management

ITHUM's value proposition is supported by its infrastructure. Its partner plays a key role in ITHUM’s business model. ITHUM has so far partnerships agreements with the following organisations: Accademia del Levante, CISCO Systems, Enetech, ICT Academy, SUN Microsystems, and ZyXEL. ITHUM's degree of influence in some of these partnership agreements is strong, as ITHUM itself is a co-founder of the partner organisation (especially in the case of Accademia del Levante, and of Enetech).

ITHUM's offering is also supported by its capabilities. Being a consultancy service company, ITHUM's capabilities are basically centred on its personnel (employers and co-workers), and they are mainly composed by a set of certifications that the organisation possesses directly, or by means of its employees.

ITHUM's services are offered thanks to a specific configuration of interconnected activities. These activities are slightly different for each family of services. These activities are shown in tab. 2. Since the two consultancy services are offered by means of the same set of activities, they are described together in the table.

Service	Activities	Activity Level
CONSULTANCY ON NETWORKING AND NEW TECHNOLOGIES		
	Analysis of Customer's Needs Identification of the Solution Configuration Implementation Support	Problem Finding and Acquisition Problem Solving Choice Execution Control and Evaluation
DESIGN OF TRAINING INITIATIVES		
	Analysis of Training Needs Identification of Training Needs Design of Training Initiative Identification of Training Resources	Problem Finding and Acquisition Problem Finding and Acquisition Choice Choice
TRAINING		
	Preparation of Didactic Material Delivery of Didactic Material to Instructor Delivery of Didactic Material to Students Lecture Follow-up	Choice Execution Execution Execution Control and Evaluation

Tab. 2. ITHUM's Value Configuration

ITHUM's infrastructure management relies on a set of resources. Human resources are mainly composed by three full-time workers (two of which are also ITHUM's co-founders), plus all the ITHUM's co-workers (about 80 potential co-workers), and ITHUM's administrative personnel.

6.2.4 ITHUM's IT infrastructure

Being a service provider, whose services are mainly human based, ITHUM possess no complex IT infrastructure. Under a geographical point of view, ITHUM's IT infrastructure is divided in two main locations (both of them are located in the centre part of Italy, in Rome).

In the first location, ITHUM has 3 servers: a VOIP server, a web intranet server, and a web server that hosts the Moodle e-learning platform. In the second location ITHUM has 1 server and 4 desktop workstations. The server is used to run Microsoft software like Microsoft Exchange, and Microsoft Sharepoint. This server also works as a file server. The four desktop workstations are used to support employers' and administrative personnel's work. Network appliances are used to establish LAN/WAN connectivity in both locations, and to grant Internet access to the whole IT infrastructure.

In terms of IT services, tab. 4 lists all those offered by ITHUM's IT infrastructure.

IT Service Name	IT Service Type
VOIP Hosting Service	IT Infrastructure Service
Moodle Hosting Service	IT Infrastructure Service
Intranet Web Hosting Service	IT Infrastructure Service
Microsoft Hosting Service	IT Infrastructure Service
Network Service 1	IT Infrastructure Service
Network Service 2	IT Infrastructure Service
Apache App	Application Service
Exchange App	Application Service
File Server App	Application Service
Moodle App	Application Service
Sharepoint	Application Service
VOIP Agent	Application Service

Tab. 4. ITHUM's IT Services

6.2.5 ITHUM's Infrastructure

Besides IT resources and human resources, ITHUM possess no other relevant resources supporting its business model. The only resources that are worth to be mentioned here are the two physical locations where IT resources are hosted, and where ITHUM's administrative personnel, and also co-workers, work.

Besides ordinary office facilities (like desks, chairs, one meeting rooms, and bookshelves), also a rack is present in both locations to host network appliances.

6.2.6 ITHUM's Financial Aspects

ITHUM's Financial Aspects are illustrated in table 3. The table shows ITHUM's main costs accounts and revenue streams. For each item the table shows its relevance as a percentage on the total amount of costs and revenues of the year.

Costs	**%**	**Revenues**	**%**
Connectivity	1,0%	Training	45,0%
Energy	2,0%	Design of Training Initiatives	25,0%
Rents	3,5%	Consultancy on New Technologies	15,0%
Wages	50,0%	Consultancy on Networking	15,0%
Consumable goods	0,5%		
External co-workers	4,0%		
Sales	36,0%		
Consultancy services	2,0%		
Transports	1,0%		
Total	100%	Total	100%

Tab. 3. ITHUM's costs and revenues

6.2.7 ITHUM's Business Model at Glance

The BMO offers many ways to represent a Business Model. Among these, a short and effective representation is the so-called "bird eye view" which shows, at glance, all the main components of a business model. Fig. 5 shows thence the bird eye view of ITHUM's Business Model.

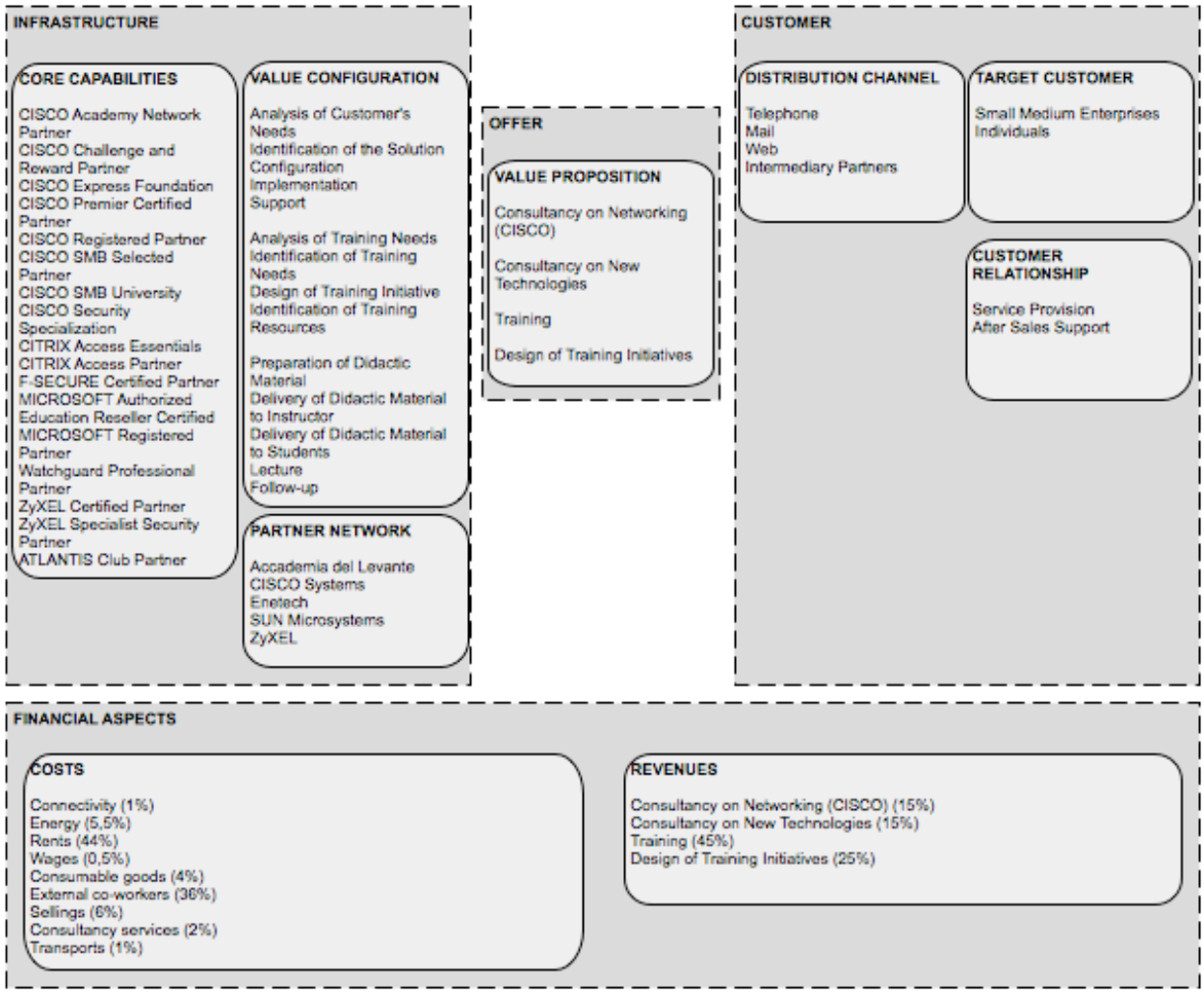

Fig. 5. ITHUM's business model at glance

The bird eye view clearly shows that a relevant element in ITHUM's business model is the set of capabilities (and in the specific case, the set of certification) that the company possesses, and that support its value proposition.

The bird eye view is, anyhow, not suitable to clearly show the impact of the IT infrastructure on ITHUM's business model. Showing only the contents of the 9 pillars of the BMO, the bird eye view does not go in deep details, displaying all the components of the business model. To clearly show the impact and the relevance of ITHUM's IT infrastructure on its business model, a different representation is then necessary.

6.2.8 Graphical representation of ITHUM's Business Model and IT infrastructure

All the data gathered from the interviews with ITHUM's management have been used to instantiate an IT-BM ontology schema. A set of supporting tools has been used to store data gartered from these interviews. These tools are: Protégé OWL v. 3.4.1 (build 537), and one of its plug-ins, Jambalaya v. 2.7.0 (build 69). The results of these activities are described in the following paragraphs.

6.2.9 ITHUM's IT Infrastructure in Details

Fig. 7 shows ITHUM's IT infrastructure as produced by the Jambalaya plug-in in Protégé. Jambalaya offers few output customisation possibilities. Thence, to improve the readability of the figure, the classes

have been ordered in a hierarchical way, starting with business services (in the higher part of the figure) and ending up with infrastructure components (in the lower part of the figure). In the left side of the figure four acronyms have been added to clarify the meaning of the boxes displayed. Provided that, each box in the figure represents an instance of a specific class of the IT-BM integrated ontology schema, the four acronyms help in identifying which kind of services they refer to. The acronyms have the following names:

- BSs: Business Services;
- ASs: Application Services;
- ISs: Infrastructure Services;
- ICs: Infrastructure Components.

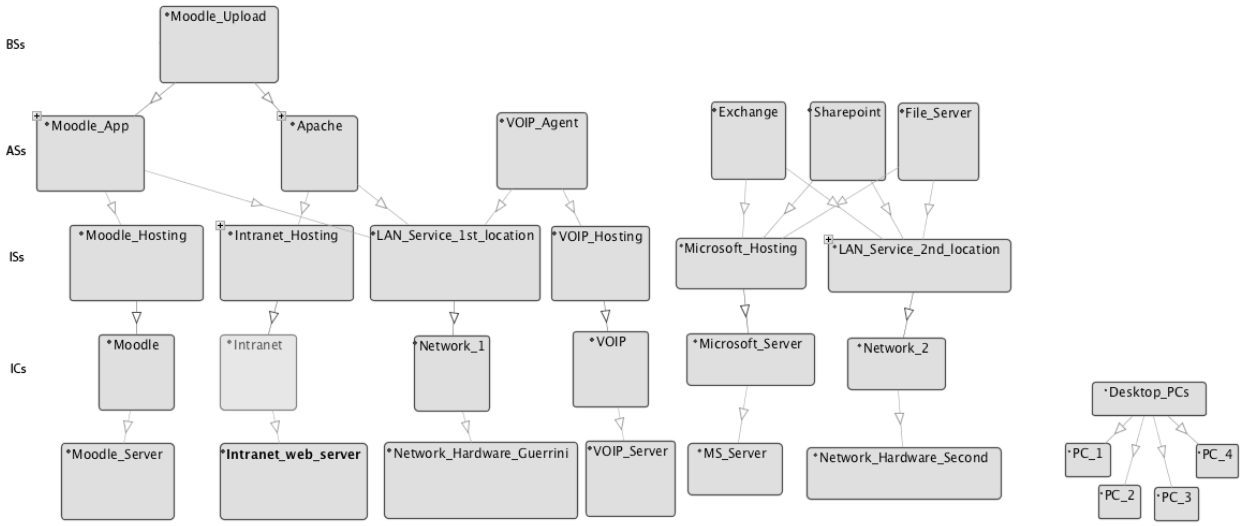

Fig. 7. ITHUM's IT infrastructure

The figure has therefore to be interpreted per rows: the row of boxes next to the BSs acronym represents all business services (in this case there is only one). The row of boxes next to the ASs acronym represents all application services, and so forth. The last two rows of boxes in the figure represent infrastructure components. Size of the boxes has no meaning in this figure and in the others that will follow.

The figure shows that ITHUM's IT infrastructure is composed by three different parts: these parts can be identified by looking at group of classes that have direct connections with each other's. The first part (the leftmost one) is the one that is located in the first of the two ITHUM's locations. This part supports the Moodle e-learning platform and the VOIP agent operations. The second part (the one in the centre) is the one located in the second of the two ITHUM's locations. This part mainly supports Microsoft's applications: Exchange, Sharepoint, and the file server operations. The third, and last, part (the rightmost one) is still located in the second of the two ITHUM's locations, and is only composed by desktop workstations used to support daily work of administrative personnel. They are also used from time to time by ITHUM's co-workers.

Among all resources (components and services) provided by ITHUM's IT infrastructure, only the ones connected to the Moodle e-learning platform are directly used in a value activity.

6.2.10 The impact of ITHUM's IT infrastructure on value activities

After having instantiated an IT-BM schema, the relationships among IT infrastructure components and value generating activities in ITHUM can be identified by querying it. Fig. 7 shows that only the Moodle e-learning platform, and the part of IT infrastructure that supports its operations, are used inside one business process in ITHUM's business model. Therefore this section focuses only on that part of the IT infrastructure.

Fig. 8 shows a large part of ITHUM's business model modelled with the IT-BM ontology. Starting from the left part, the figure shows that one of the three parts of ITHUM's IT infrastructure supports one of the four ITHUM's value propositions (Training). The part of the infrastructure that supports this value proposition is composed by network hardware, an intranet web server, two applications (Apache and Moodle), and the business service that delivers Moodle's functionalities to the business process with which ITHUM provides training services. Out of the five activities that compose this business process, only the second and the third (the distribution of the didactic material to instructors and to students) make use of the IT infrastructure.

The business process in discussion (which is called "Training_Giving" in the figure) supports the Training offering. The right part of the figure shows that the Training value offering is directed to two groups of customers (individuals, and SME), through two distribution channels (the direct channel, and the intermediary partners). The relationships with the customers are managed by means of the service provision activity and the after sales support.

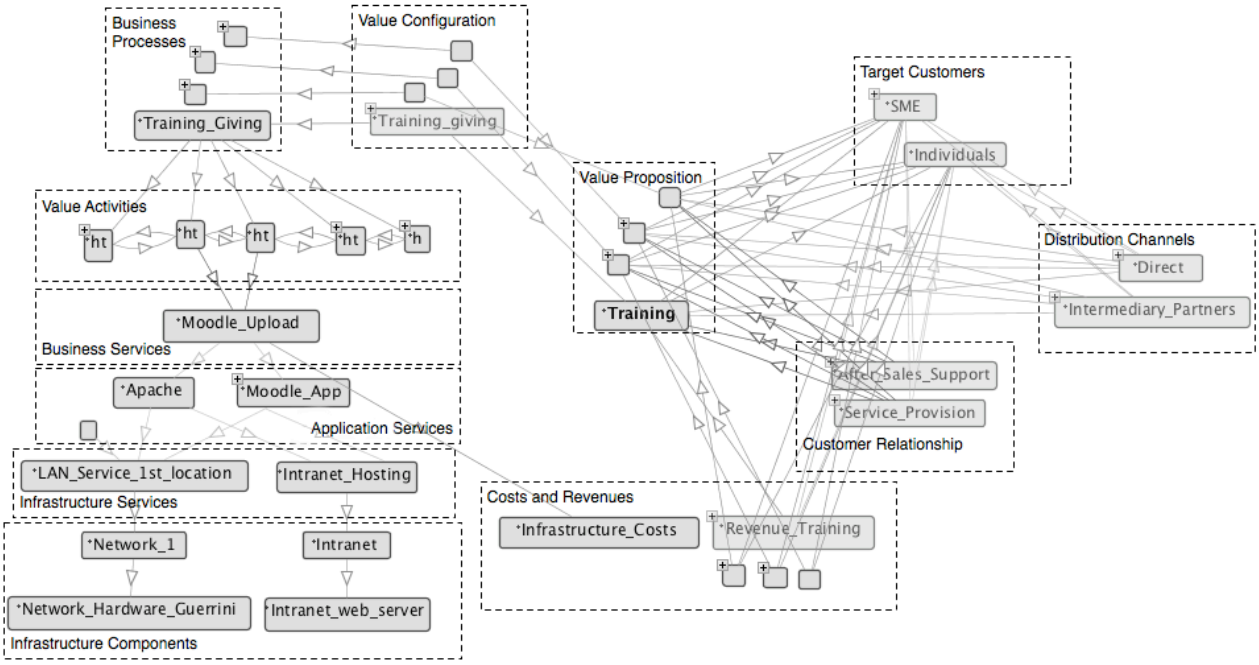

Fig. 8. The impact of ITHUM's IT infrastructure on value generating activities

7. Conclusions and Limitations

The main contribution of this Ph.D. dissertation is the integration of the BMO and the OLPIT ontology in the IT-BM ontology, to support the identification of the impacts of IT resources on value generating activities in an organisation. Answering the research question, the IT-BM ontology, as testified by the ITHUM case, is a suitable tool to identify, represent, and communicate the impact of IT resources on value generating activities in an organisation.

The identification of the impacts of IT resources on value generating activities can be of support for several applications. A first possible application of the proposed approach could be the identification of which IT resources are necessary for the execution of value generating activities. Since the proposed method groups activities on the basis of the value delivered to the customer, and also indicates their contribution to the total profitability of the company, it could be possible to identify which are the key strategical IT resources that better contribute to the value generation process of the organisation. This could allow managers (both IT and not) to take decisions on the IT infrastructure on a profit, or customer, oriented base.

To be able to identify the impact of IT resources on value generating activities, the proposed approach requires a certain amount of investigation. When the approach has to be applied in a real life scenario, there is the necessity to investigate the structure of the business model and the structure of IT resources in the organisational context. Usually knowledge on these aspect can be found in many places inside an organisation. In any case, the application of the approach requires a global effort, which involves both the IT management and the business management side. The proposed approach has therefore the capability of putting IT and business managers around the same table, to discuss about a common problem, and to share a common understanding on the IT/Business relationships, fostering a shared understanding, crucial to derive competitive advantage from IT resources (Ray et al., 2007).

Moreover, as seen from the IT perspective alone, the proposed approach can help IT management in explaining and communicating, in a more comprehensive way, which is the contribution of the IT division to the organisation.

A further possible application of the proposed approach lies only in the IT management field. The proposed approach, and in particular the OLPIT ontology, promotes a more deep understanding of IT resources that encompasses the resources themselves, their use, and their interdependencies. This understanding can promote IT management, pushing approaches like the adoption of CMDBs a bit further.

Furthermore, IT manager could have the possibility to assess their IT infrastructure under a customer/supplier perspective, by identifying its readiness and its capability of fulfilling business needs and requests. A prototypical application that shows how to do such infrastructure assessments can be found in vom Brocke et al. (2009), and has also been reported in the dissertation as a test case for the OLPIT ontology.

7.1 Limitations

Even though the approach proposed in the Ph.D. dissertation has been developed and tested, as much as possible, in real life scenarios, being proposed for the first time, its limitations have also to be taken into consideration. There are two main kinds of limitations to discuss. The first kind regards the research itself, the second one regards the applicability of the proposed method.

7.2 Research Limitations

Regarding the research itself, a possible limitation of the approach proposed in this Ph.D. dissertation, regards the limitations of the different amount of scenarios in which the approach has been tested. IT resources can impact value generating activities in different ways in each of the three possible value configurations defined by Stabel e Fjeldstad (1998). The proposed approach has been mainly tested on value shops. Since IT resources could impact activities in a different way when they are part of a value chain, a value shop, or a value network, even though the approach is general, considerations on its outcomes on any kind of value configurations require further research.

7.3 Applicability Limitations

A second set of possible limitations regards the scenarios in which the proposed approach can be applied, the conditions in which it can be applied, and the level of understanding that it contributes to gain on the IT/activity relationships phenomenon.

First of all, to be applied, the proposed approach requires that the organisation has an IT infrastructure that (almost) directly contributes to its value proposition. The proposed approach could not therefore be applied in contexts where there is no IT (and this is of course obvious), or where the IT is not directly involved in business activities (if any).

The proposed approach identifies the link between IT resources and activities only in the case these resources deliver values to activities. This value delivering process consists in practical capabilities of these IT resources that make possible, or simply support, the execution of activities and business processes. The more the link between these IT resources and the activities is blurred, the less is the usefulness of the IT-BM application. There are some IT resources that are not directly involved inside business processes (for example, the act of sending and e-mail). Being not part of a business process execution, they are unlikely to be captured by the IT-BM approach. For example, the desktop workstations in the ITHUM test case can be taken into consideration. In the given example they are not used by any activity in the business process. In this case, the application of the IT-BM does not provide too much help in understanding how these resources supports ITHUM's value delivery, even though they do, since they support ITHUM's personnel administrative work.

Probably it is easy to understand that in an industrial company an ERP or a CRM system contribute better to organisational performance than desktop computers. Anyhow, desktop computers allow individuals to work inside the organisation. Simple activities like e-mail sending, web browsing, document writing, and others, are indirect parts of the value generating process, but are, so far, not easily captured with the application of the IT-BM.

Another aspect that has to be taken into consideration is the level of granularity. In the test cases that have been described in the Ph.D. dissertation, the level of granularity was intentionally intermediate. This is due to the necessity of keeping the instantiated model as simple as possible, mainly because complexity reduces communication effectiveness. Also some attestations from industrial contexts where the OLPIT ontology has been developed suggest that pursuing the maximum level of details is counterproductive, as it might led in the failure of the initiative due to an excess of complexity and information overloads.

The understanding of the relationships among IT resources and value generating activities that the IT—BM approach contributes to gain, also depends on the type of IT infrastructure that is under investigation. Under a theoretical point of view IT resources can be shared among several activities. Thence a single IT resource can provide more than one service (for example, an entire ERP system). The degree of understanding that the approach contributes to gain can therefore decrease with the increase of the number of shared resources in the IT infrastructure.

A final remark regarding the practical application of the proposed approach regards eventual supporting tools. Even if they are simple, the test cases that have been realised for the Ph.D. dissertation are based on a conspicuous amount of data representing the two realities that have been investigated. These data have been collected by means of interviews or direct observations, and they have been stored in different instances of the IT-BM ontology schema, using the Protégé ontology editor software. The Protégé software acted therefore as a supporting tool for the application of the IT-BM. This software offers a lot of functionalities that are mainly targeted to support the ontology engineering process. The software supports the development activity in a proper way, but it is a bit limited (and in some cases it is even too complex) for the everyday usage of the ontology. The two test cases described in this dissertation benefited from visualisation and query capabilities of Protégé and its plug-ins. Anyhow, to be able to fully exploit the potential of the proposed approach, a dedicated supporting tool should be identified (or developed).

References

Andersson, B., Bergholtz, M., Edirisuriya, A., Ilayperuma, T., Johannesson, P., Gordijn, J., Grégoire, B., Schmitt, M., Dubois, E., Abels, S., Hahn, A., Weigand, H., & Wangler, B. (2006). Towards a reference ontology for business models. Lecture Notes in Computer Science, 4215, 482–496.

Avison, D., Baskerville, R.L., Myers, M.D. (2001). Controlling action research projects. Information Technology & People, 14(1), 28-45.

Barney, J. B. (1991a). Firm resources and sustained competitive advantage. Journal of Management, 17(1),

99–120.
Barney, J. B. (1991b). The resource based view of strategy: Origins, implications, and prospects. Journal of Management, 17(1), 97–211.
Baskerville, R.L. (1999). Investigating Information Systems with Action Research. Communication of the Association for Information Systems, 2(19).
Baskerville, R.L. and Myers, M.D. (2004). Special Issue on Action Research in Information Systems: Making IS Research Relevant to Practice – Foreword. MISQ, 28(3), 329-335.
Bienstock, C. C., Gillenson, M. L., & Sanders, T. C. (2002). The complete taxonomy of web busines models. Quarterly Journal of Electronic Commerce, 3(2), 173–182.
Bienstock, C.C., Gillenson, M.L., Sanders, T.C. (2002). The complete taxonomy of web Business Models. Quarterly Journal of Electronic Commerce, 3(2), 173-182.
Braccini, A.M., Spagnoletti, P., D'Atri, A. (2008). Analysing Business Models for Cross Border E-Services Provided by the Chambers of Commerce. In Proceedings of 16th European Conference on Information Systems, Golden, W., Acton, T., Conboy, K., van der Heijden, H., Ruunainen, V.K. Eds, 978-0-9553159-2-3.
Daft, R. L. (1983). Organizational Theory and Designs. West Pub. Co. St. Paul.
Feng, H., Froud, J., Johal, S., Haslam, C., & Williams, K. (2001). A new business model? the capital market and the new economy. Economy and Society Volume, 30(4), 467–503.
Force, I.-I. T. (2003). Handbook on Enterprise Architecture, chapter GERAM: The Generalised Enterprise Reference Architecture and Methodology, Version 1.6.3. Springer, Berlin.
Fox, M. S., Barbuceanu, M., Grünninger, M., & Lin, J. (1998). An Organization Ontology for Enterprise Modeling. Menlo Park CA: AAAI/MIT Press.
Gordijn, J. & Tan, Y. H. (2005). A design methodology for modeling trustworthy value webs. International Journal of Electronic Commerce, 9(3), 31–48.
Gruber, T. R. (1993). A translation approach to portable ontology specifications. Knowledge Acquisition, 5(2), 199–220.
Gruninger, M. (1998). Enterprise modelling. AI Magazine, 19(3), 109–121.
Grünninger, M. (2003). Enterprise Modelling. Springer, Berlin.
Guarino, N. (1998). Formal ontology and information systems. In N. Guarino (Ed.), Proceedings of FOIS'98 Conference: IOS Press.
Guarino, N., Musen, M.A. (2005). Introduction. Applied Ontology: Focusing on content, Applied Ontology 1(1), 1-5.
Hevner, A.R., March, S.T., Park, J., Ram, S. (2004). Design Science in Information Systems Research, MISQ, 28(1), 75-105.
Im, K.S., Dow, K.E., Grover, V. (2001). Research Report: A Reexamination of IT Investment and the Market Value of the Firm – An Event Study Methodology. Information Systems Research, 12(1), 103-117.
Jiménez-Ruiz, E., Grau, B. C., Horrocks, I., & Berlanga, R. (2009). Ontology integration using mappings: Towards getting the right logical consequences. In The Semantic
Lewis, M. (1999). The New New Thing. London: Hodder & Stoughton.
Magretta, J. (2002). Why Business Models Matter. Harvard Business Review, May.
Magretta, J. (2002). Why business models matter. Harvard Business Review.
McCarthy, W. E. (1982). The rea accounting model: A generalized framework for accounting systems in a shared data environment. The Accounting Review.
Melville, N., Kraemer, K., Gurbaxani, V. (2004). Review: Information technology and organizational performance: an integrative model of IT business value. MIS Quarterly, 28(2), 283-322.
Nickels, D. (2004). IT-Business Alignment: What we know that we still don't know. In Proceedings of the 7th Annual Conference of the Southern Association for Information Systems, 79-84.
Oh, W., Pinsonneault, A. (2007). On the assessment of the strategic value of information technologies: conceptual and analytical approaches. MIS Quarterly, 31(2), 239-265.

Orlikowski, W.J., Iacono, C.S. (2001). Desperately Seeking the "IT" in IT Research – A Call to Theorizing the IT Artifact. Information Systems Research, 12(2), 121-134.

Osterwalder, A., Pigneur, Y., Tucci, C.L. (2005). Clarifying Business Models: origins, present, and future oft he concept. Communications of the Association for Information Systems, 15, 1-25.

Porter, M.E. (2001). Strategy and the internet. Harvard Business Review

Ray, G. Muhanna, W.A., Barney, J.B. (2007). The Role of Shared IT-Business Understanding. Communications of the ACM, 50(12), 87-91.

Scheepers, H., Scheepers, R. (2008). A process-focused decision framework for analyzing the business value potential of IT investments. Information Systems Frontiers, 10 (3), 321-330.

Schweizer, L. (2005). Concept and evolution of business models. Journal of General Management, 31(2), 37–56.

Seddon, P.B., Graeser, V., Willcocks, L.P. (2002). Measuring Organizational IS Effectiveness: an Overview and Update of Senior Management Perspecitves. The DATA BASE for Advances in Information Systems, 33(2), 11-28.

Serrano, A., den Hengst, M. (2005). Modelling the integration of BP and IT using business process simulations. Journal of Enterprise Information Management, 18(6), 740-759.

Soh, C. & Markus, M. L. (1995). How it creates business value: a process theory synthesis. In G. Ariav (Ed.), Proceedings of 16th International Conference on Information Systems.

Stabell, C.B., Fjeldstad, O.D. (1998). Configuring value for competitive advantage: on chains, shops and networks. Strategic Management Journal, 19(55),413-437.

Sure, Y., Akkermans, H., Broekstra, J., Davies, J., Ding, Y., Duke, A., Engels, R., Fensel, D., Horrocks, I., Iosif, V., Kampman, A., Kiryakov, A., Klein, M., Lau, Th., Ognyanov, D., Reimer, U., Simov, K., Studer, R., van der Meer, J, van Harmelen, F. (2003). On-to-knowledge: semantic web enabled knowledge management. In: Zhong, N., Liu, J., Yao, Y. (eds.), Web Intelligence, 227-300, Springer, Berlin.

Tallon, P.P. (2007). Does IT pay to focus? An analysis of IT business value under single and multi-focused business strategies. Journal of Strategic Information Systems, 16(3), 278-300.

Thompson, J. D. (1967). Organizations in Action. McGraw-Hill, New York.

Tikkanen, H., Lamberg, J. A., Parvinen, P., & Kallunki, J. P. (2005). Managerial cognition, action and the business model of the firm. Management Decision, 43(6), 789–809.

Tillquist, J., Rodgers, W. (2005). Using Asset Specificity and Asset Scope to Measure the Value of IT. Communications of the ACM, 48(1), 75-80.

Uschold, M., King, M., Moralee, M., & Zorgios, Y. (1998). The enterprise ontology. The Knowledge Engineering Review, 12.

vom Brocke, J., Braccini, A. M., Sonnenberg, C., Ender, E. (2009). A Process Oriented Assessment oft he IT Infrastructure Value: a Proposal of an Ontology Based Approach. LNBIP, 21, 13-24.

Wagner, H.T., Weitzel, T. (2007). Towards an IT production function – Understanding routines as foundamental for IT value creation. Journal of Enterprise Information Management, 20(4), 380-395.

Web: Research and Application, volume 5554/2009 of LNCS (pp. 173–187). Springer Berlin/Heidelberg.

Wernerfelt, B. (1984). The resource-based view of the firm. Strategic Management Journal, 5(2), 171–180.